NODE=S009

π^0 $I^G(J^{PC}) = 1^-(0^{-+})$

NODE=S009

We have omitted some results that have been superseded by later experiments. The omitted results may be found in our 1988 edition Physics Letters **B204** 1 (1988).

π^0 MASS

NODE=S009M

The value is calculated from $m_{\pi^\pm}$ and $(m_{\pi^\pm} - m_{\pi^0})$. See also the notes under the $\pi^\pm$ Mass Listings.

NODE=S009M

NODE=S009M

VALUE (MeV)	*DOCUMENT ID*
134.9768±0.0005 OUR FIT	Error includes scale factor of 1.1.

$m_{\pi^\pm} - m_{\pi^0}$

NODE=S009D

Measurements with an error > 0.01 MeV have been omitted.

NODE=S009D

NODE=S009D

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
4.5936 ±0.0005 OUR FIT				
4.5936 ±0.0005 OUR AVERAGE				
4.59364±0.00048	CRAWFORD	91	CNTR	$\pi^- p \to \pi^0 n$, n TOF
4.5930 ±0.0013	CRAWFORD	86	CNTR	$\pi^- p \to \pi^0 n$, n TOF
• • • We do not use the following data for averages, fits, limits, etc. • • •				
4.59366±0.00048	CRAWFORD	88B	CNTR	See CRAWFORD 91
4.6034 ±0.0052	VASILEVSKY	66	CNTR	
4.6056 ±0.0055	CZIRR	63	CNTR	

π^0 MEAN LIFE

NODE=S009T

Most experiments measure the π^0 width which we convert to a lifetime. ATHERTON 85 is the only direct measurement of the π^0 lifetime. The two Primakoff measurements from 1970 have been excluded from our average because they suffered model-related systematics unknown at the time. More information on the π^0 lifetime can be found in BERNSTEIN 13.

NODE=S009T

NODE=S009T

VALUE (10^{-17} s)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
8.43 ±0.13 OUR AVERAGE		Error includes scale factor of 1.2.			
8.337±0.056±0.112		[1] LARIN	20	PRMX	Primakoff effect
8.5 ±1.1		[2] BYCHKOV	09	PIBE	$\pi^+ \to e^+ \nu \gamma$ at rest
8.4 ±0.5 ±0.5	1182	[3] WILLIAMS	88	CBAL	$e^+ e^- \to e^+ e^- \pi^0$
8.97 ±0.22 ±0.17		ATHERTON	85	CNTR	Direct measurement
8.2 ±0.4		[4] BROWMAN	74	CNTR	Primakoff effect
• • • We do not use the following data for averages, fits, limits, etc. • • •					
8.32 ±0.15 ±0.18		[5] LARIN	11	PRMX	Primakoff effect
5.6 ±0.6		BELLETTINI	70	CNTR	Primakoff effect
9 ±0.68		KRYSHKIN	70	CNTR	Primakoff effect
7.3 ±1.1		BELLETTINI	65B	CNTR	Primakoff effect

[1] LARIN 20 reported this lifetime value from a measurement of $\Gamma(\pi^0 \to \gamma\gamma) = 7.802 \pm 0.052 \pm 0.105$ eV, combining data from PrimEX-II on 12C and 28Si targets with previous PrimEx-I LARIN 11 measurements. This result supersedes LARIN 11. NODE=S009T;LINKAGE=A

[2] BYCHKOV 09 obtains this using the conserved-vector-current relation between the vector form factor F_V and the π^0 lifetime. NODE=S009T;LINKAGE=BY

[3] WILLIAMS 88 gives $\Gamma(\gamma\gamma) = 7.7 \pm 0.5 \pm 0.5$ eV. We give here $\tau = \hbar/\Gamma$(total). NODE=S009T;LINKAGE=A1

[4] BROWMAN 74 gives a π^0 width $\Gamma = 8.02 \pm 0.42$ eV. The mean life is $\hbar/\Gamma$. NODE=S009T;LINKAGE=B

[5] LARIN 11 reported $\Gamma(\pi^0 \to \gamma\gamma) = 7.82 \pm 0.14 \pm 0.17$ eV which we converted to mean life $\tau = \hbar/\Gamma$(total). NODE=S009T;LINKAGE=LA

π^0 DECAY MODES

NODE=S009215;NODE=S009

For decay limits to particles which are not established, see the appropriate Search sections (A^0 (axion) and Other Light Boson (X^0) Searches, etc.).

NODE=S009

	Mode		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	
Γ_1	2γ		(98.823 ± 0.034) %	S=1.5	DESIG=1
Γ_2	$e^+e^-\gamma$		(1.174 ± 0.035) %	S=1.5	DESIG=2
Γ_3	γ positronium		$(1.82\pm0.29)\times10^{-9}$		DESIG=20
Γ_4	$e^+e^+e^-e^-$		$(3.34\pm0.16)\times10^{-5}$		DESIG=3
Γ_5	e^+e^-		$(6.46\pm0.33)\times10^{-8}$		DESIG=6
Γ_6	4γ		$<2\times10^{-8}$	CL=90%	DESIG=5
Γ_7	invisible		$<4.4\times10^{-9}$	CL=90%	DESIG=23
Γ_8	$\nu_e\overline{\nu}_e$		$<1.7\times10^{-6}$	CL=90%	DESIG=11
Γ_9	$\nu_\mu\overline{\nu}_\mu$		$<1.6\times10^{-6}$	CL=90%	DESIG=12
Γ_{10}	$\nu_\tau\overline{\nu}_\tau$		$<2.1\times10^{-6}$	CL=90%	DESIG=13
Γ_{11}	$\gamma\nu\overline{\nu}$		$<1.9\times10^{-7}$	CL=90%	DESIG=15
	Charge conjugation (*C*) or Lepton Family number (*LF*) violating modes				NODE=S009;CLUMP=A
Γ_{12}	3γ	*C*	$<3.1\times10^{-8}$	CL=90%	DESIG=4
Γ_{13}	μ^+e^-	*LF*	$<3.8\times10^{-10}$	CL=90%	DESIG=14
Γ_{14}	μ^-e^+	*LF*	$<3.2\times10^{-10}$	CL=90%	DESIG=22
Γ_{15}	$\mu^+e^- + \mu^-e^+$	*LF*	$<3.6\times10^{-10}$	CL=90%	DESIG=8

CONSTRAINED FIT INFORMATION

An overall fit to 2 branching ratios uses 6 measurements and one constraint to determine 3 parameters. The overall fit has a $\chi^2 =$ 4.6 for 4 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle\delta x_i\delta x_j\right\rangle/(\delta x_i\cdot\delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\rm total}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_2	-100	
x_4	0	-1
	x_1	x_2

π^0 BRANCHING RATIOS

NODE=S009220

$\Gamma(e^+e^-\gamma)/\Gamma(2\gamma)$ Γ_2/Γ_1

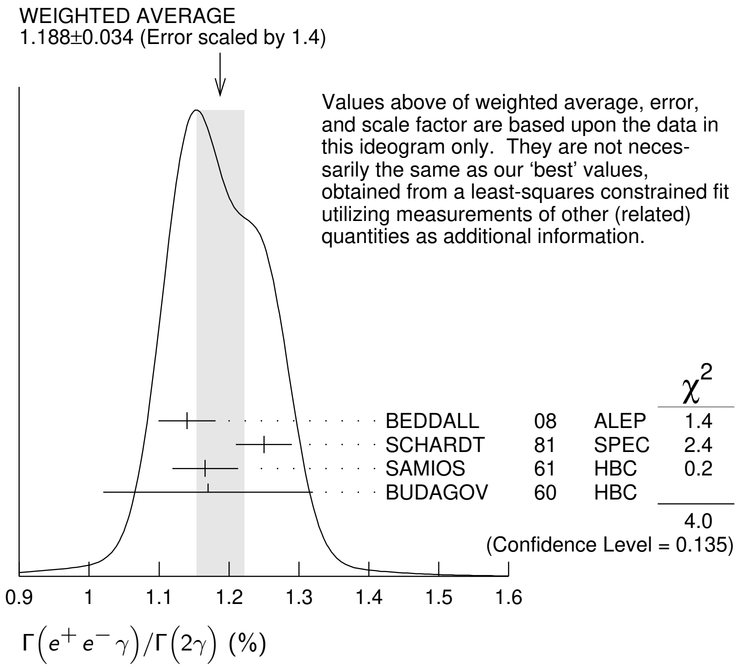
NODE=S009R1
NODE=S009R1

VALUE (%)	EVTS	DOCUMENT ID		TECN	COMMENT
1.188 ±0.035 OUR FIT Error includes scale factor of 1.5.					
1.188 ±0.034 OUR AVERAGE Error includes scale factor of 1.4. See the ideogram below.					
$1.140\pm0.024\pm0.033$	12.5k	[1] BEDDALL	08	ALEP	$e^+e^-\to Z\to$ hadrons
1.25 ± 0.04		SCHARDT	81	SPEC	$\pi^-p\to n\pi^0$
1.166 ± 0.047	3k	[2] SAMIOS	61	HBC	$\pi^-p\to n\pi^0$
1.17 ± 0.15	27	BUDAGOV	60	HBC	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.1559\pm0.0047\pm0.0106$	60k	[3] ABOUZAID	19	KTEV	$K_L\to 3\pi^0$ in flight
1.196		JOSEPH	60	THEO	QED calculation

[1] BEDDALL 08 value is obtained from ALEPH archived data. NODE=S009R1;LINKAGE=BE

[2] SAMIOS 61 value uses a Panofsky ratio = 1.62. NODE=S009R1;LINKAGE=S

[3] ABOUZAID 19 measured a value of $(0.3920\pm0.0016\pm0.0036)$% from 1999 KTEV data in $K_L\to 3\pi^0\to 5\gamma e^+e^-$ decays, normalised to $K_L\to 3\pi^0$, for m(ee) > 15 MeV and then extrapolated it to the full m(ee) range using the Mikaelian and Smith predictions for the mass spectrum. NODE=S009R1;LINKAGE=A



$\Gamma(\gamma\,\text{positronium})/\Gamma(2\gamma)$ — Γ_3/Γ_1

NODE=S009R12
NODE=S009R12

VALUE (units 10^{-9})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
1.84±0.29	277	AFANASYEV	90	CNTR	pC 70 GeV

$\Gamma(e^+e^+e^-e^-)/\Gamma(2\gamma)$ — Γ_4/Γ_1

NODE=S009R3
NODE=S009R3

VALUE (units 10^{-5})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
3.38±0.16 OUR FIT					
3.38±0.16 OUR AVERAGE					
3.46±0.19	30.5k	[1] ABOUZAID	08D	KTEV	$K^0_L \to \pi^0\pi^0\pi^0_{DD}$
3.18±0.30	146	[2] SAMIOS	62B	HBC	

[1] This ABOUZAID 08D value includes all radiative final states. The error includes both statistical and systematic errors. The correlation between the Dalitz-pair planes gives a direct measurement of the π^0 parity. The $\pi^0 2\gamma^*$ form factor is measured and limits are placed on a scalar contribution to the decay. NODE=S009R3;LINKAGE=AB

[2] SAMIOS 62B value uses a Panofsky ratio = 1.62. NODE=S009R3;LINKAGE=N

$\Gamma(e^+e^-)/\Gamma_{\text{total}}$ — Γ_5/Γ

NODE=S009R13

Experimental results are listed; branching ratios corrected for radiative effects are given in the footnotes. BERMAN 60 found B($\pi^0 \to e^+e^-$) $\geq 4.69 \times 10^{-8}$ via an exact QED calculation. NODE=S009R13

NODE=S009R13

VALUE (units 10^{-8})	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
6.46±0.33 OUR AVERAGE						
6.44±0.25±0.22	794	[1] ABOUZAID	07	KTEV		$K^0_L \to 3\pi^0$ in flight
6.9 ±2.3 ±0.6	21	[2] DESHPANDE	93	SPEC		$K^+ \to \pi^+\pi^0$
7.6 $^{+2.9}_{-2.8}$ ±0.5	8	[3] MCFARLAND	93	SPEC		$K^0_L \to 3\pi^0$ in flight
• • • We do not use the following data for averages, fits, limits, etc. • • •						
6.09±0.40±0.24	275	[4] ALAVI-HARATI	99C	SPEC	0	Repl. by ABOUZAID 07

[1] ABOUZAID 07 result is for $m_{e^+e^-}/m_{\pi^0} > 0.95$. With radiative corrections the result becomes $(7.48 \pm 0.29 \pm 0.25) \times 10^{-8}$. NODE=S009R13;LINKAGE=AB

[2] The DESHPANDE 93 result with bremsstrahlung radiative corrections is $(8.0 \pm 2.6 \pm 0.6) \times 10^{-8}$. NODE=S009R13;LINKAGE=A

[3] The MCFARLAND 93 result is for B[$\pi^0 \to e^+e^-$, $(m_{e^+e^-}/m_{\pi^0})^2 > 0.95$]. With radiative corrections it becomes $(8.8^{+4.5}_{-3.2} \pm 0.6) \times 10^{-8}$. NODE=S009R13;LINKAGE=B

[4] ALAVI-HARATI 99C quote result for B[$\pi^0 \to e^+e^-$, $(m_{e^+e^-}/m_{\pi^0})^2 > 0.95$] to minimize radiative contributions from $\pi^0 \to e^+e^-\gamma$. After radiative corrections they obtain $(7.04 \pm 0.46 \pm 0.28) \times 10^{-8}$. NODE=S009R13;LINKAGE=AH

$\Gamma(e^+e^-)/\Gamma(2\gamma)$ — Γ_5/Γ_1

NODE=S009R5
NODE=S009R5

VALUE (units 10^{-7})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<1.3	90		NIEBUHR	89	SPEC	$\pi^- p \to \pi^0 n$ at rest
<5.3	90		ZEPHAT	87	SPEC	$\pi^- p \to \pi^0 n$ 0.3 GeV/c
$1.7 \pm 0.6 \pm 0.3$		59	FRANK	83	SPEC	$\pi^- p \to n\pi^0$
1.8 ± 0.6		58	MISCHKE	82	SPEC	See FRANK 83
$2.23^{+2.40}_{-1.10}$	90	8	FISCHER	78B	SPRK	$K^+ \to \pi^+\pi^0$

$\Gamma(4\gamma)/\Gamma_{total}$ — Γ_6/Γ

NODE=S009R4
NODE=S009R4

VALUE (units 10^{-8})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
< 2	90		MCDONOUGH	88	CBOX	$\pi^- p$ at rest
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<160	90		BOLOTOV	86C	CALO	
<440	90	0	AUERBACH	80	CNTR	

$\Gamma(\text{invisible})/\Gamma_{total}$ — Γ_7/Γ

NODE=S009R00

The limits apply to all "invisible" channels, including in particular neutrino-antineutrino final states, obtained with laboratory experiments. Astrophysical and cosmological limits exist and are many orders of magnitude lower, but they are model dependent.

NODE=S009R00

NODE=S009R00

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$< 4.4 \times 10^{-9}$	90	CORTINA-GIL	21C	SPEC	$K^+ \to \pi^+\pi^0(\gamma)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$< 0.27 \times 10^{-6}$	90	ARTAMONOV	05A	B949	$K^+ \to \pi^+\pi^0$
$< 0.83 \times 10^{-6}$	90	ATIYA	91	B787	$K^+ \to \pi^+\nu\nu'$
$<24 \times 10^{-6}$	90	HERCZEG	81	RVUE	$K^+ \to \pi^+\nu\nu'$

$\Gamma(\nu_e\overline{\nu}_e)/\Gamma_{total}$ — Γ_8/Γ

NODE=S009R8
NODE=S009R8

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<1.7	90	DORENBOS...	88	CHRM	Beam dump, prompt ν
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<3.1	90	[1] HOFFMAN	88	RVUE	Beam dump, prompt ν

[1] HOFFMAN 88 analyzes data from a 400-GeV BEBC beam-dump experiment.

NODE=S009R8;LINKAGE=A

$\Gamma(\nu_\mu\overline{\nu}_\mu)/\Gamma_{total}$ — Γ_9/Γ

NODE=S009R9
NODE=S009R9

VALUE (units 10^{-6})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
<1.6	90	8.7	AUERBACH	04	LSND	800 MeV p on Cu
<3.1	90		[1] HOFFMAN	88	RVUE	Beam dump, prompt ν
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<7.8	90		DORENBOS...	88	CHRM	Beam dump, prompt ν

[1] HOFFMAN 88 analyzes data from a 400-GeV BEBC beam-dump experiment.

NODE=S009R9;LINKAGE=A

$\Gamma(\nu_\tau\overline{\nu}_\tau)/\Gamma_{total}$ — Γ_{10}/Γ

NODE=S009R10
NODE=S009R10

VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT
<2.1	90	[1] HOFFMAN	88	RVUE	Beam dump, prompt ν
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<4.1	90	DORENBOS...	88	CHRM	Beam dump, prompt ν

[1] HOFFMAN 88 analyzes data from a 400-GeV BEBC beam-dump experiment.

NODE=S009R10;LINKAGE=A

$\Gamma(\gamma\nu\overline{\nu})/\Gamma_{total}$ — Γ_{11}/Γ

NODE=S009R15

Standard Model prediction is 6×10^{-18}.

NODE=S009R15
NODE=S009R15

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<1.9 \times 10^{-7}$	90	CORTINA-GIL	19	SPEC	$K^+ \to \pi^+\gamma\nu\overline{\nu}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<6 \times 10^{-4}$	90	ATIYA	92	CNTR	$K^+ \to \gamma\nu\overline{\nu}\pi^+$

$\Gamma(3\gamma)/\Gamma_{total}$ Γ_{12}/Γ

NODE=S009R2

Forbidden by C invariance.

NODE=S009R2
NODE=S009R2

VALUE (units 10^{-8})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
< 3.1	90		MCDONOUGH	88	CBOX	$\pi^- p$ at rest
• • • We do not use the following data for averages, fits, limits, etc. • • •						
< 38	90	0	HIGHLAND	80	CNTR	
<150	90	0	AUERBACH	78	CNTR	
<490	90	0	[1] DUCLOS	65	CNTR	
<490	90		[1] KUTIN	65	CNTR	

[1] These experiments give $B(3\gamma/2\gamma) < 5.0 \times 10^{-6}$.

NODE=S009R2;LINKAGE=D

$\Gamma(\mu^+ e^-)/\Gamma_{total}$ Γ_{13}/Γ

NODE=S009R11

Forbidden by lepton family number conservation.

NODE=S009R11
NODE=S009R11

VALUE (units 10^{-9})	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
< 0.38	90	0	APPEL	00	SPEC	$K^+ \to \pi^+ \mu^+ e^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<16	90		LEE	90	SPEC	$K^+ \to \pi^+ \mu^+ e^-$
<78	90		CAMPAGNARI	88	SPEC	See LEE 90

$\Gamma(\mu^- e^+)/\Gamma_{total}$ Γ_{14}/Γ

NODE=S009R16

Forbidden by lepton family number conservation.

NODE=S009R16
NODE=S009R16

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<3.2 × 10^{-10}	90	ALIBERTI	21	NA62	$K^+ \to \pi^+ e^+ \mu^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<3.4 × 10^{-9}	90	APPEL	00B	B865	$K^+ \to \pi^+ e^+ \mu^-$

$[\Gamma(\mu^+ e^-) + \Gamma(\mu^- e^+)]/\Gamma_{total}$ Γ_{15}/Γ

NODE=S009R7

Forbidden by lepton family number conservation.

NODE=S009R7
NODE=S009R7

VALUE (units 10^{-9})	CL%	DOCUMENT ID		TECN	COMMENT
< 0.36	90	ABOUZAID	08C	KTEV	$K^0_L \to 2\pi^0 \mu^\pm e^\mp$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 17.2	90	KROLAK	94	E799	In $K^0_L \to 3\pi^0$
<140		HERCZEG	84	RVUE	$K^+ \to \pi^+ \mu e$
< 2 × 10^{-6}		HERCZEG	84	THEO	$\mu^- \to e^-$ conversion
< 70	90	BRYMAN	82	RVUE	$K^+ \to \pi^+ \mu e$

OCCUR=2

π^0 ELECTROMAGNETIC FORM FACTOR

NODE=S009225

The amplitude for the process $\pi^0 \to e^+ e^- \gamma$ contains a form factor F(x) at the $\pi^0 \gamma\gamma$ vertex, where $x = [m_{e^+e^-}/m_{\pi^0}]^2$. The parameter a in the linear expansion F(x) = 1 + ax is listed below.

NODE=S009225

All the measurements except that of BEHREND 91 are in the time-like region of momentum transfer.

LINEAR COEFFICIENT OF π^0 ELECTROMAGNETIC FORM FACTOR

NODE=S009A
NODE=S009A

NEW

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
3.32± 0.29 OUR AVERAGE					
[(3.35 ± 0.31) × 10^{-2} OUR 2025 AVERAGE]					
3.0 ± 1.0	0.4M	[1] ADLARSON	17A	SPEC	$\gamma p \to \pi^0 p$, $\pi^0 \to e^+ e^- \gamma$
3.68± 0.51±0.25	1.1M	LAZZERONI	17	SPEC	$K^\pm \to \pi^0 \pi^\pm$; $\pi^0 \to e^+ e^- \gamma$
2.6 ± 2.4 ±4.8	7.5k	FARZANPAY	92	SPEC	$\pi^- p \to \pi^0 n$ at rest
2.5 ± 1.4 ±2.6	54k	MEIJERDREES	92B	SPEC	$\pi^- p \to \pi^0 n$ at rest
3.26± 0.26±0.26	127	[2] BEHREND	91	CELL	$e^+ e^- \to e^+ e^- \pi^0$
−11 ± 3 ±8	32k	FONVIEILLE	89	SPEC	Radiation corr.
• • • We do not use the following data for averages, fits, limits, etc. • • •					
12 $^{+5}_{-4}$		[3] TUPPER	83	THEO	FISCHER 78 data
10 ± 3	31k	[4] FISCHER	78	SPEC	Radiation corr.
1 ±11	2.2k	DEVONS	69	OSPK	No radiation corr.
−15 ±10	7.6k	KOBRAK	61	HBC	No radiation corr.
−24 ±16	3.0k	SAMIOS	61	HBC	No radiation corr.

[1] ADLARSON 17A use the A2 tagged photon facility at the Mainz Microtron, MAMI to measure π^0 Dalitz decay. The error is the total estimated experimental uncertainty . NODE=S009A;LINKAGE=B

[2] BEHREND 91 estimates that their systematic error is of the same order of magnitude as their statistical error, and so we have included a systematic error of this magnitude. The value of *a* is obtained by extrapolation from the region of large space-like momentum transfer assuming vector dominance. NODE=S009A;LINKAGE=A

[3] TUPPER 83 is a theoretical analysis of FISCHER 78 including 2-photon exchange in the corrections. NODE=S009A;LINKAGE=T

[4] The FISCHER 78 error is statistical only. The result without radiation corrections is $+0.05 \pm 0.03$. NODE=S009A;LINKAGE=F

π^0 REFERENCES

NODE=S009

We have omitted some papers that have been superseded by later experiments. The omitted papers may be found in our 1988 edition Physics Letters **B204** 1 (1988).

NODE=S009

ALIBERTI	21	PRL 127 131802	R. Aliberti *et al.*	(NA62 Collab.)	REFID=61497
CORTINA-GIL	21C	JHEP 2102 201	E. Cortina Gil *et al.*	(NA62 Collab.)	REFID=61280
LARIN	20	SCI 368 506	I. Larin *et al.*	(PrimEx II Collab.)	REFID=60642
ABOUZAID	19	PR D100 032003	E. Abouzaid *et al.*	(KTeV Collab.)	REFID=59908
CORTINA-GIL	19	JHEP 1905 182	E. Cortina Gil *et al.*	(NA62 Collab.)	REFID=59689
ADLARSON	17A	PR C95 025202	P. Adlarson *et al.*	(A2 Collab. at MAMI)	REFID=58154
LAZZERONI	17	PL B768 38	C. Lazzeroni *et al.*	(NA62 Collab.)	REFID=57890
BERNSTEIN	13	RMP 85 49	A.M. Bernstein, B. R. Holstein	(AMHT, MIT)	REFID=55232
LARIN	11	PRL 106 162303	I. Larin *et al.*	(PrimEx Collab.)	REFID=16617
BYCHKOV	09	PRL 103 051802	M. Bychkov *et al.*	(PSI PIBETA Collab.)	REFID=52934
ABOUZAID	08C	PRL 100 131803	E. Abouzaid *et al.*	(FNAL KTeV Collab.)	REFID=52385
ABOUZAID	08D	PRL 100 182001	E. Abouzaid *et al.*	(FNAL KTeV Collab.)	REFID=52386
BEDDALL	08	EPJ C54 365	A. Beddall, A. Beddall	(UGAZ)	REFID=52486
ABOUZAID	07	PR D75 012004	E. Abouzaid *et al.*	(KTeV Collab.)	REFID=51593
ARTAMONOV	05A	PR D72 091102	A.V. Artamonov *et al.*	(BNL E949 Collab.)	REFID=50943
AUERBACH	04	PRL 92 091801	L.B. Auerbach *et al.*	(LSND Collab.)	REFID=49874
APPEL	00	PRL 85 2450	R. Appel *et al.*	(BNL 865 Collab.)	REFID=47754
Also		Thesis, Yale Univ.	D.R. Bergman		REFID=48055
Also		Thesis, Univ. Zurich	S. Pislak		REFID=48056
APPEL	00B	PRL 85 2877	R. Appel *et al.*	(BNL 865 Collab.)	REFID=47770
ALAVI-HARATI	99C	PRL 83 922	A. Alavi-Harati *et al.*	(FNAL KTeV Collab.)	REFID=47075
KROLAK	94	PL B320 407	P. Krolak *et al.*	(EFI, UCLA, COLO, ELMT+)	REFID=43710
DESHPANDE	93	PRL 71 27	A. Deshpande *et al.*	(BNL E851 Collab.)	REFID=43362
MCFARLAND	93	PRL 71 31	K.S. McFarland *et al.*	(EFI, UCLA, COLO+)	REFID=43363
ATIYA	92	PRL 69 733	M.S. Atiya *et al.*	(BNL, LANL, PRIN+)	REFID=42140
FARZANPAY	92	PL B278 413	F. Farzanpay *et al.*	(ORST, TRIU, BRCO+)	REFID=41990
MEIJERDREES	92B	PR D45 1439	R. Meijer Drees *et al.*	(PSI SINDRUM-I Collab.)	REFID=42012
ATIYA	91	PRL 66 2189	M.S. Atiya *et al.*	(BNL, LANL, PRIN+)	REFID=41479
BEHREND	91	ZPHY C49 401	H.J. Behrend *et al.*	(CELLO Collab.)	REFID=41497
CRAWFORD	91	PR D43 46	J.F. Crawford *et al.*	(VILL, UVA)	REFID=41389
AFANASYEV	90	PL B236 116	L.G. Afanasyev *et al.*	(JINR, MOSU, SERP)	REFID=41201
Also		SJNP 51 664	L.G. Afanasyev *et al.*	(JINR)	REFID=41298
		Translated from YAF 51 1040.			
LEE	90	PRL 64 165	A.M. Lee *et al.*	(BNL, FNAL, VILL, WASH+)	REFID=41094
FONVIEILLE	89	PL B233 65	H. Fonvieille *et al.*	(CLER, LYON, SACL)	REFID=41041
NIEBUHR	89	PR D40 2796	C. Niebuhr *et al.*	(SINDRUM Collab.)	REFID=40874
CAMPAGNARI	88	PRL 61 2062	C. Campagnari *et al.*	(BNL, FNAL, PSI+)	REFID=40620
CRAWFORD	88B	PL B213 391	J.F. Crawford *et al.*	(PSI, UVA)	REFID=40779
DORENBOS...	88	ZPHY C40 497	J. Dorenbosch *et al.*	(CHARM Collab.)	REFID=40701
HOFFMAN	88	PL B208 149	C.M. Hoffman	(LANL)	REFID=40646
MCDONOUGH	88	PR D38 2121	J.M. McDonough *et al.*	(TEMP, LANL, CHIC)	REFID=40685
PDG	88	PL B204 1	G.P. Yost *et al.*	(LBL+)	REFID=40022
WILLIAMS	88	PR D38 1365	D.A. Williams *et al.*	(Crystal Ball Collab.)	REFID=40567
ZEPHAT	87	JP G13 1375	A.G. Zephat *et al.*	(OMICRON Collab.)	REFID=40875
BOLOTOV	86C	JETPL 43 520	V.N. Bolotov *et al.*	(INRM)	REFID=40310
		Translated from ZETFP 43 405.			
CRAWFORD	86	PRL 56 1043	J.F. Crawford *et al.*	(SIN, UVA)	REFID=10744
ATHERTON	85	PL 158B 81	H.W. Atherton *et al.*	(CERN, ISU, LUND+)	REFID=10743
HERCZEG	84	PR D29 1954	P. Herczeg, C.M. Hoffman	(LANL)	REFID=10742
FRANK	83	PR D28 423	J.S. Frank *et al.*	(LANL, ARZS)	REFID=10740
TUPPER	83	PR D28 2905	G.B. Tupper, T.R. Grose, M.A. Samuel	(OKSU)	REFID=10741
BRYMAN	82	PR D26 2538	D.A. Bryman	(TRIU)	REFID=10738
MISCHKE	82	PRL 48 1153	R.E. Mischke *et al.*	(LANL, ARZS)	REFID=10739
HERCZEG	81	PL 100B 347	P. Herczeg, C.M. Hoffman	(LANL)	REFID=10736
SCHARDT	81	PR D23 639	M.A. Schardt *et al.*	(ARZS, LANL)	REFID=10737
AUERBACH	80	PL 90B 317	L.B. Auerbach *et al.*	(TEMP, LASL)	REFID=10734
HIGHLAND	80	PRL 44 628	V.L. Highland *et al.*	(TEMP, LASL)	REFID=10735
AUERBACH	78	PRL 41 275	L.B. Auerbach *et al.*	(TEMP, LASL)	REFID=10730
FISCHER	78	PL 73B 359	J. Fischer *et al.*	(GEVA, SACL)	REFID=10732
FISCHER	78B	PL 73B 364	J. Fischer *et al.*	(GEVA, SACL)	REFID=10733
BROWMAN	74	PRL 33 1400	A. Browman *et al.*	(CORN, BING)	REFID=10727
BELLETTINI	70	NC 66A 243	G. Bellettini *et al.*	(PISA, BONN)	REFID=10723
KRYSHKIN	70	JETP 30 1037	V.I. Kryshkin, A.G. Sterligov, Y.P. Usov	(TMSK)	REFID=10724
		Translated from ZETF 57 1917.			
DEVONS	69	PR 184 1356	S. Devons *et al.*	(COLU, ROMA)	REFID=10722
VASILEVSKY	66	PL 23 281	I.M. Vasilevsky *et al.*	(JINR)	REFID=10721
BELLETTINI	65B	NC 40A 1139	G. Bellettini *et al.*	(PISA, FIRZ)	REFID=10716
DUCLOS	65	PL 19 253	J. Duclos *et al.*	(CERN, HEID)	REFID=10717
KUTIN	65	JETPL 2 243	V.M. Kutjin, V.I. Petrukhin, Y.D. Prokoshkin	(JINR)	REFID=10719
		Translated from ZETFP 2 387.			
CZIRR	63	PR 130 341	J.B. Czirr	(LRL)	REFID=10692
SAMIOS	62B	PR 126 1844	N.P. Samios *et al.*	(COLU, BNL)	REFID=10708
KOBRAK	61	NC 20 1115	H. Kobrak	(EFI)	REFID=10706
SAMIOS	61	PR 121 275	N.P. Samios	(COLU, BNL)	REFID=10707
BERMAN	60	NC 18 1192	S. Berman, D. Geffen		REFID=47500
BUDAGOV	60	JETP 11 755	Y.A. Budagov *et al.*	(JINR)	REFID=10702
		Translated from ZETF 38 1047.			
JOSEPH	60	NC 16 997	D.W. Joseph	(EFI)	REFID=10703